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STORRS POND DAM (NH 0 (U) CORPS OF ENGINEERS WALTHAM
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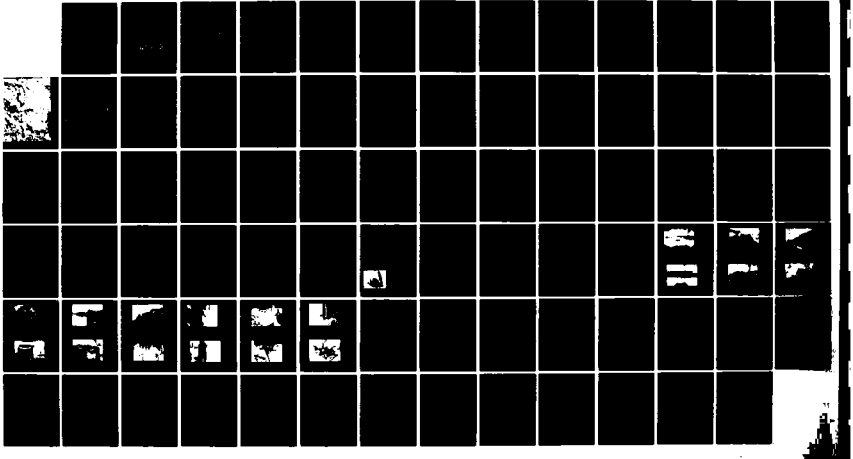

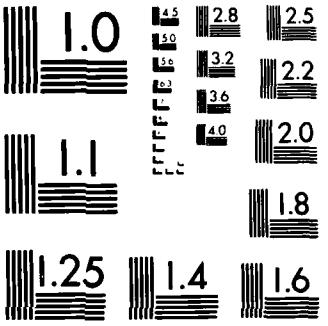

CONNECTICUT RIVER BASIN

HANOVER, NEW HAMPSHIRE

STORRS POND DAM

NH 00050

NHWRB NO. 108.07

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

NOVEMBER 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin,
Hanover, New Hampshire,
Camp Brook,

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is an earthen embankment structure with an overall length of 140 ft. The maximum height of the dam is 33.75 ft. The visual inspection revealed that the dam is in fair condition. It also revealed that deterioration of the concrete surface of the spillway and the invert of the spillway discharge tunnel. It is small in size with a hazard potential of significant.

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STORRS POND DAM

NH 00050

NHWRB 108.07

CONNECTICUT RIVER BASIN
HANOVER, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LETTER OF TRANSMITTAL

FROM THE CORPS OF ENGINEERS TO THE STATE

TO BE SUPPLIED BY THE CORPS OF ENGINEERS

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.: 00050

Name of Dam: Storrs Pond Dam

Town: Hanover

County and State: Grafton, New Hampshire

Stream: Camp Brook

Date of Inspection: October 26, 1979

Storrs Pond Dam is an earthen embankment structure with an overall length of 140 feet. Maximum height as measured from the crest of the dam to the streambed is 33.75 feet. Top width is 10 feet, and the upstream and downstream embankments are on a 2 1/2 horizontal to 1 vertical slope. The spillway is a circular drop inlet type, with an inside diameter of 10.0 feet and is located near the center of the dam. The discharge tunnel exits on the downstream toe of the dam, and has overall dimensions of 10 feet by 10 feet, with the invert of a circular shape. The outlet works are located at the invert of the left side of the spillway riser. The 2.8 foot wide octagonal opening is controlled by a 3.0 foot diameter gate. The gate is operated by a hand crank at the crest of the riser. There is no means of access to the gate operator from the dam. The dam was constructed in 1934. The impoundmment is used for recreation. A set of drawings of the dam are available, however, no design calculations or construction data were revealed.

The visual inspection revealed that the dam is in fair condition. The visual inspection revealed deterioration of the concrete surface of the spillway and the invert of the spillway discharge tunnel, rotted stumps on the dam, brush and wet vegetation on the crest and slopes, and debris in the downstream channel.

Based on a maximum storage of 520 acre-feet and a height of 34 feet, Storrs Pond Dam falls within the small size classification. The dam's hazard classification has been established as significant based on the potential overtopping of Route 10 by the breach flood wave. Based on the small size of the dam and its significant hazard classification and in accordance with Corps of Engineers Guidelines, the test flood inflow should be of a magnitude ranging from a 100 year

frequency flood to 1/2 the Probable Maximum Flood (PMF). One half the PMF was used for the test flood inflow, which is 2940 cfs. The routed test flood outflow of 2420 cfs overtops the dam by approximately 1.8 feet. With the water surface at the top of dam the spillway capacity is approximately 1244 cfs (about 51 percent of the routed test flood outflow).

It is recommended that the owner engage a qualified, registered, professional engineer to (1) design an acceptable means of removing the tree roots and backfilling the voids (2) design adequate slope protection for the upstream slope of the dam (3) investigate spillway adequacy and (4) design repairs for the invert of the spillway discharge tunnel. Remedial measures include development of a downstream warning system and removal of brush and cut vegetation from the crest and slopes of the dam.

The recommendations and remedial measures are described in Section 7 and should be addressed within 1 year after receipt of this Phase I - Inspection Report by the owner.

Gordon H. Slaney, Jr.

Gordon H. Slaney, Jr., P.E.
Project Engineer

HOWARD NEEDLES TAMMEN & BERGENDOFF
Boston, Massachusetts

This Phase I Inspection Report on Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

THIS SHEET TO BE FURNISHED BY THE CORPS OF ENGINEERS

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might be otherwise detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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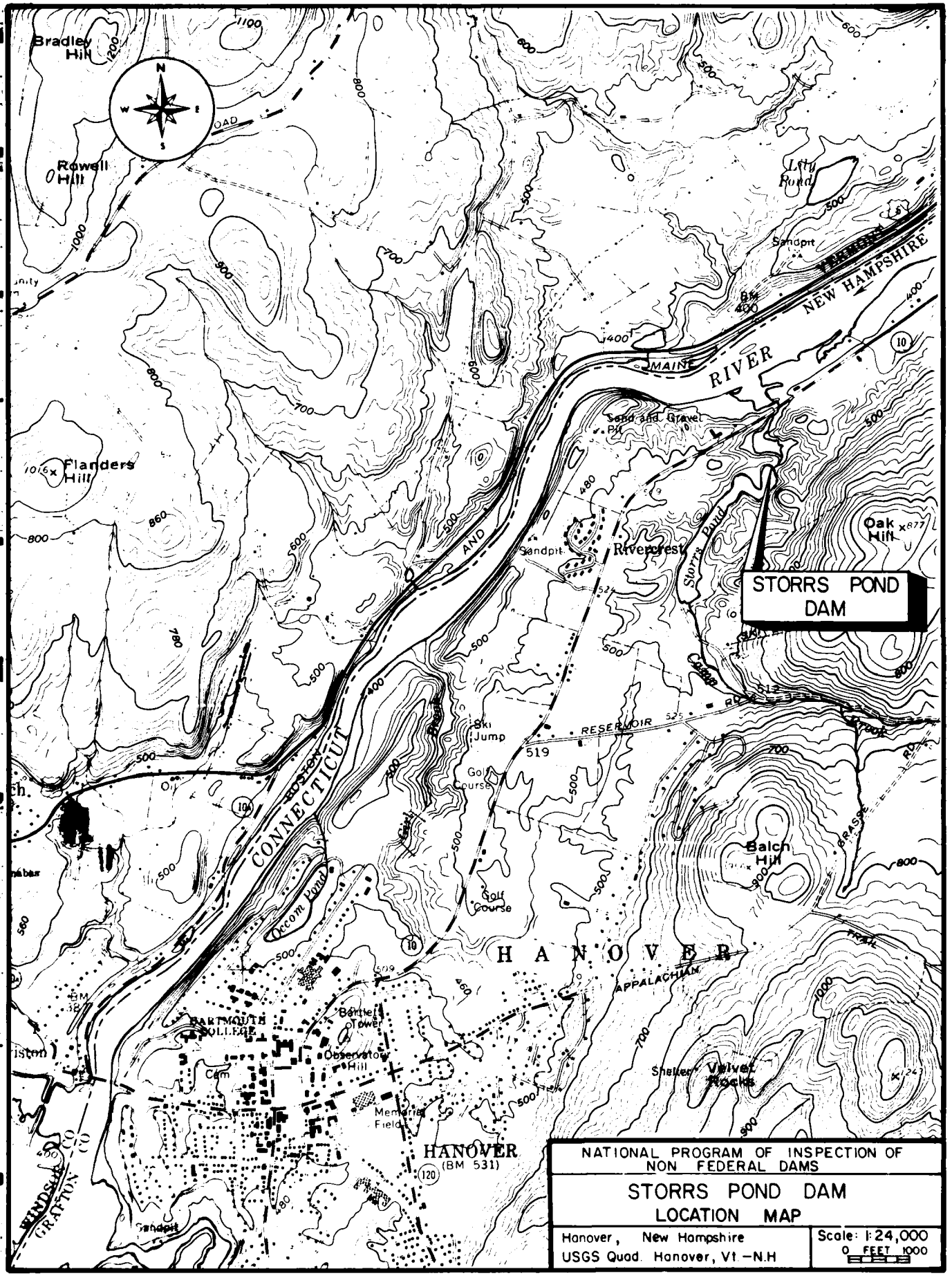


NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS

STORRS POND DAM
LOCATION MAP

Hanover, New Hampshire
USGS Quad. Hanover, Vt – N.H

Scale: 1:24,000
0 FEET 1000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
STORRS POND DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Howard, Needles, Tammen & Bergendoff has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Howard, Needles, Tammen & Bergendoff under a letter of October 11, 1979 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-79-C-0060 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Storrs Pond Dam is located along Camp Brook about 1,000 feet upstream of the Connecticut River in the Town of Hanover, New Hampshire. The dam is shown on U.S.G.S. Quadrangle, Hanover, Vermont-New Hampshire, with approximate coordinates N43°31'17", E72°15'35", Grafton County, New Hampshire. The location of the dam is shown on the preceding page.

b. Description of Dam and Appurtenances. Storrs Pond Dam is an earthen embankment structure. Overall length is 140 feet. The maximum height as measured from the streambed to the crest of dam is 33.75 feet. The crest of the dam is 10 feet wide. The upstream and downstream embankments are on a 2 1/2 horizontal to 1 vertical slope. Riprap was placed on the upstream slope near the water line. The crest and downstream slope have a vegetative cover. There is a core wall varying in width from 1.5 to 2 feet constructed of concrete along the center of the dam. The dam is on a ledge foundation.

The spillway is a circular drop inlet located near the center of the dam, and is constructed of concrete. It has a 10 foot inside diameter and the concrete crest is 7.05 feet below the crest of the dam. The crest of the spillway is raised by about 1.5 feet with flashboards constructed of boiler plate and set with steel pins. The flashboards are considered permanent. The drop inlet discharges through a 10 foot square reinforced concrete tunnel through the dam and core wall. The tunnel has a circular shaped invert. The tunnel outlets at the downstream slope directly into the stream channel. The exit is protected by a concrete headwall. A pond drain gate 3.0 feet in diameter is located on the left side of the spillway and is operated by a long stem and hand crank. The opening in the spillway riser structure is octagonal in shape and 2.8 feet across.

Figure 1 located in Appendix B, shows a plan of the dam and its appurtenant structures. Photographs of each structure are shown in Appendix C.

c. Size Classification. Small (hydraulic height - 34 feet, storage - 520 acre-feet) classification based on the height being less than 40 feet and the storage being less than 1,000 acre-feet as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The potential for damage posed by this dam is classified as significant. Failure of the dam with the water level at the top of dam would result in a flood wave about 4.5 feet high over the Route 10 highway embankment located about 1,000 feet downstream of the dam.

e. Ownership. This dam is owned by the Hanover Improvement Society, P.O. Box 106, Hanover, New Hampshire 03755.

f. Operator. This dam is operated by the Hanover Improvement Society, P.O. Box 106, Hanover, New Hampshire 03755. Telephone No. 603-643-2408.

g. Purpose of Dam. The impoundment is used for recreation.

h. Design and Construction History. This dam constructed in 1934 as a Works Progress Administration project. There is no record of any major modifications to the dam since construction.

i. Normal Operating Procedures. The normal water level is at the crest of the permanent flashboards on the spillway. No data was available regarding any regular operating procedures or how often the site was visited.

1.3 Pertinent Data

a. Drainage Area. The area tributary to Storrs Pond consists of 2.74 square miles of wooded, mountainous terrain. There is little development as 68 percent of the watershed is part of a water supply catchment area. There are two reservoirs upstream of Storrs Pond which have a total 1.86 square miles of tributary area. Maximum elevation in the drainage basin is 1,280 feet NGVD. There are five peaks over 1,000 feet in the area. Normal pond levels is at about elevation 417.1.

The reservoir is long and narrow being about 3,000 feet long and an average of 230 feet wide. The banks at the downstream end are very steep and wooded. At the upstream end there is a recreation area and camp ground.

b. Discharge at Dam Site.

(1) The outlet works consist of a 3 foot diameter gate set at an invert of 392.14. The gate is located on the left side of the drop inlet spillway riser. It is operated by a handwheel at the crest of the drop inlet. When the water surface is at the crest of the permanent flashboards, the maximum capacity of the outlet is about 160 cfs.

(2) There are no records of maximum discharge at the site.

(3) The spillway capacity with the water surface the top of dam, elevation 422.69, would be about 1,244 cfs.

(4) The spillway capacity with the water surface at the test flood elevation of 424.51 would be about 1,360 cfs.

(5) The total project discharge at the test flood elevation of 424.51 is approximately 2,420 cfs.

c. Elevation (feet above NGVD)

(1) Streambed at centerline of dam - 388.94

(2) Maximum tailwater - unknown

(3) Upstream invert of outlet works - 392.14

(4) Normal pool - 417.14

(5) Full flood control pool - N/A

(6) Spillway crest (permanent spillway) - 415.64
(permanent flashboards) - 417.14

(7) Design surcharge - N/A

(8) Top Dam - 422.69

(9) Test Flood Surcharge - 424.5

d. Reservoir (miles)

(1) Length of Maximum Pool - 0.59

(2) Length of Normal Pool - 0.57

(3) Length of Flood Control Pool - N/A

e. Storage (gross acre-feet)

(1) Normal Pool - 350

(2) Flood Control Pool - N/A

(3) Spillway Crest Pool - 300

(4) Top of Dam - 520

f. Reservoir Surface (acres)

(1) Normal Pool - 34

(2) Flood Control Pool - N/A

(3) Spillway Crest - 34

(4) Test Flood Pool - 34

(5) Top Dam - 34

g. Dam

(1) Type - earth

(2) Length - 140 feet

(3) Height - 33.75 feet

(4) Top Width - 10 feet

(5) Side Slopes - upstream and downstream 2 1/2 horizontal to 1 vertical

(6) Zoning - unknown

(7) Impervious core - conrete

(8) Cutoff - unknown

(9) Grout Curtain - unknown

(10) Other - unknown

h. Diversion and Regulating Tunnel

See Section j below.

i. Spillway

(1) Type - circular drop inlet

(2) Length of Weir - 10 feet diameter inside. 40.8 feet long around crest of flashboards

(3) Crest Elevation - 415.64 original crest
417.14 permanent flashboards

(4) Gates - none

(5) Upstream Channel - none

(6) Downstream Channel - The spillway outlet tunnel discharges to a natural channel immediately downstream of the dam. The channel is in a steep narrow valley for a distance of about 500 feet.

j. Regulating Outlets - The outlet works consist of a 3 foot diameter gate set at an invert of 392.14. The gate is located on the left side of the drop inlet spillway riser. It is operated by a handwheel at the crest of the drop inlet. When the water surface is at the crest of the permanent flashboards, the maximum capacity of the outlet is about 150 cfs.

SECTION 2
ENGINEERING DATA

2.1 Design

A set of drawings (three sheets) are available for Storrs Pond Dam. However, no design calculations or specifications were made available. The dam was constructed in 1934. There is no record of any major modifications to the dam since that time.

2.2 Construction

No construction records are available for use in evaluating the dam.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. There is no design engineering data available other than the set of drawings noted in Paragraph 2-1. These plans are available at the New Hampshire Water Resources Board, Concord, New Hampshire.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. The field inspection indicated that the external features of Storrs Pond Dam substantially agree with those shown on the available plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Storrs Pond Dam was made on October 26, 1979. The inspection team consisted of personnel from Howard, Needles, Tammen & Bergendoff and Geotechnical Engineers, Inc. Inspection checklists, completed during the inspection, are included in Appendix A. At the time of inspection, the water level was approximately 9.3 feet below the concrete crest of the spillway. The upstream face of the dam could only be inspected above this level.

b. Dam. Visual inspection of the dam indicated that it is in fair condition. The dam consists of an earth embankment about 140 feet long and 34 feet high.

Upstream Slope

The upstream slope is inclined at 2.5 horizontal to 1 vertical. At the time of inspection, the reservoir had been lowered to facilitate repairs to the concrete drop inlet structure. The upstream slope is shown in Photo No. 3. Note the poor riprap protection on the slope and the area of the slope missing riprap shown in the background of the photo.

Photo No. 7 shows a large dead tree stump located about 1 to 2 feet below the dam crest.

A small excavation on the upstream face below the normal waterline elevation revealed the near surface soils to be silty fine sand and sandy silt. These types of soils are easily eroded and require adequate riprap slope protection to prevent erosion and sloughing.

Crest

The crest of the dam is about 16 feet wide and, as shown in Photo No. 4, has an uneven topography. The high and low points varied between one and two feet. It could not be determined whether the variances is above or below the design crest elevation. No significant misalignment of the crest was observed and there was no evidence of instability and sliding of the slopes that would account for the uneven topography of the dam crest.

Downstream Slope

The downstream slope is inclined at 2.5 horizontal to 1 vertical. The slope, which is shown in Photo No. 5, has been overgrown with brush and trees. At the time of inspection, the trees had been cut, but no stumps had been removed. Photo No. 6 shows a tree stump located a few feet below the dam crest.

c. Appurtenant Structures. Visual inspection of the concrete circular drop inlet spillway, spillway tunnel and pond drain system did not reveal any immediate stability problems. The concrete structure of the circular spillway appeared to be in generally fair condition. However, there was considerable concrete deterioration in the form of cracks and spalling. Repair patches were visible.

The circular spillway structure, as seen in Photo Nos. 8, 9 & 10, consists of three elements: a circular inlet overflow control, a vertical transition (cylindrical structure) and outlet tunnel. The circular spillway structure has provision for crest adjustment which was in place. The spillway structure is located at the toe of the embankment near the center of the dam. Visual inspection revealed that the concrete spillway structure has extensive decay on the top and the side surface. (Photo Nos. 9 & 10). The gate operating mechanism appeared to be operational, as the reservoir level was recently lowered. There was no means of access to the gate operating mechanism. There were remains of supports for a catwalk from the dam to the gate wheel as seen in Photo No. 11. The outlet gate, as seen in Photo No. 13, was subject to some minor leakage but otherwise appeared to be in fair condition.

The outlet tunnel consists of a concrete box structure, size and location of which are shown in Figure 1 in Appendix B. Visual inspection revealed that the bottom slab of spillway tunnel is badly deteriorated. Heavy concrete erosion is concentrated at the center of the tunnel slab. In a few locations the slab erosion is extended to tunnel walls. Cracks and spalling were noted on both walls. There is also evidence of efflorescence, a whitish crystalline deposit on the concrete surface, mostly at the concrete cracks shown in Photo Nos 12 & 14.

The concrete retaining walls at the end of the discharge tunnel, Photo Nos. 15 & 16, are badly deteriorated in the form of cracks and spalling. The left wall Photo No. 17 is separated from the tunnel structure. The wall has moved horizontally approximately 2 inches downstream from its original position.

d. Reservoir Area. The reservoir is long and narrow. The downstream end of the pond has very steep banks, up to 60 feet high. The banks are heavily wooded and there are many fallen trees along the shoreline. The reservoir level had recently been lowered to about 9 feet below its normal level.

e. Downstream Channel. The channel downstream of the dam is about 12 feet wide. Just downstream of the dam there is some debris in the channel and overhanging trees as seen in Photo No. 18. For about 500 feet the valley section is about 50 feet wide with high steep banks, which are heavily wooded. Further downstream the channel opens up to an area which has ponded due to the Route 10 highway embankment. The culvert under Route 10 was submerged by the tailwater from the Connecticut River and could not be seen.

3.2 Evaluation

Visual examination indicates that the dam is in fair condition. Visual examination revealed the following:

(a) Deterioration of concrete on the spillway and the floor of the discharge tunnel.

(b) No easy means of access to the outlet gate mechanical operator.

(c) Loss of rip-rap protection on the upstream face of the dam.

(d) Several large stumps on the dam.

(e) Brush and cut vegetation on the crest and downstream face of the dam.

(f) Debris in the channel immediately downstream of the dam.

(g) Downstream movement of the left wingwall of the spillway discharge tunnel.

(h) Many fallen trees along the reservoir shoreline.

(i) The crest of the dam was uneven.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

Storrs Pond Dam is used for recreation. The normal water level is at the crest of the permanent flashboards on the spillway. The 3 foot diameter outlet is usually closed.

4.2 Maintenance of Dam

There is no regular maintenance procedure in effect. Repairs are made on an as needed basis.

4.3 Maintenance of Operating Facilities

There is no regular maintenance procedure for the operating facilities. Repairs are made as needed.

4.4 Description of Warning Systems

There are no warning systems in effect for this facility.

4.5 Evaluation

The current operation and maintenance procedures for this dam are inadequate to insure that problems encountered can be remedied within a reasonable period of time.

The owner should establish a continuing operational and maintenance procedure as well as establishing a warning system to follow in the event of emergency conditions.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. General. Storrs Pond Dam is an earthen structure with an overall length of 140 feet. Maximum height is 33.75 feet as measured from the crest to the streambed. Top width is 10 feet. The upstream and downstream slopes are on a 2 1/2 horizontal to 1 vertical slope. The crest and downstream slope are protected with a vegetative cover. The spillway is a circular drop inlet type located near the center of the dam, with a total weir length of 40.8 feet at the crest of the permanent flashboards. The discharge tunnel is 10 feet square with a circular shaped invert, which discharges to the downstream toe of the dam. The outlet works consist of a 2.8 foot wide octagonal shaped opening on the base and left side of the spillway riser. There is a 3 foot diameter gate which is operated at the crest of the riser with a hand crank.

The reservoir is used for recreation. The dam is classified as small in size with a height of 34 feet and a maximum storage of 520 acre-feet.

b. Design Data. No original hydrologic or hydraulic design data were available.

c. Experience Data. There are no records of maximum discharge at the site.

d. Visual Observations. No evidence of damage to any portion of the project from overtopping was visible at the time of inspection.

e. Test Flood Analysis. No detailed design and operational information are available for this dam. The hydrologic evaluation was performed using information gathered by field investigation, watershed characteristics, and Probable Maximum Flood (PMF) curves prepared by the Corps of Engineers. In accordance with Corps of Engineer Guidelines the significant hazard classification and small size classification of this dam warrants a test flood magnitude ranging from a 100-year frequency flood to 1/2 the PMF. A test flood equal to 1/2 the PMF was used. A test flood inflow of 2,940 cfs is based on a watershed of 2.74 square miles in mountainous terrain. Inflow to Storrs Pond was calculated by adding the routed test flood outflow from Lower Reservoir, 1.86 square miles, to the runoff directly tributary to Storrs Pond.

The routed test flood outflow was determined in accordance with Corps of Engineers Guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharge, and the hydraulic characteristics of the dam. The circular opening drop inlet spillway was considered as a morning-glory type drop inlet. The permanent flashboards were used as a crest, and an inside radius of 6.5 feet was used for the weir calculations. It was assumed that the sharp edge of the crest would approximate the morning-glory spillway hydraulics. Control was at the crest for all flow conditions as the capacity of the discharge tunnel was always greater than the crest capacity. Discharge over the dam crest was computed as flow over a weir. The routing was started with the water surface at the crest of the flashboards. The routed test flood outflow was determined to be approximately 2,420 cfs. As the maximum capacity of the spillway is approximately 1,244 cfs (about 51 percent of the routed test flood outflow) the dam will be overtopped by 1.8 feet.

f. Dam Failure Analysis. The impact of failure of the dam was assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs prepared by the Corps of Engineers. The breach discharge was estimated with the water surface at the crest of the dam and a breach width equal to 40 percent of the mid-height length of the dam. Prior to the breach of dam the downstream river stage would be about 6.4 feet with the spillway at a full capacity discharge of 1,244 cfs. Breach of dam would result in a flow of 10,100 cfs. The maximum spillway discharge and breach discharge are not added as it was assumed that the spillway discharge tunnel would be in the part of the dam that failed. The downstream damage was estimated using the Route 10 highway embankment as a control point. The embankment is located 1,000 feet downstream of the dam and about 15 feet above the streambed. The waterway opening under Route 10 is below the tailwater of the Connecticut River. It was not included in the stage-discharge calculations because of its tailwater condition and small size. Using an average valley cross-section in the reach between the dam and Route 10, a reach outflow of 8,960 cfs was computed. This discharge would result in a depth of flow at Route 10 of about 4.5 feet above the roadway surface over an estimated distance of 300 feet. There are no structures between the dam and Route 10. The downstream side of the Route 10 embankment is at the Connecticut River.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observation. The visual inspection of Storrs Pond Dam did not reveal any immediate stability problems however, the poor condition of the riprap and the large amount of tree stumps left on the dam could lead to future stability problems. In addition, further undermining of the walls of the spillway discharge tunnel by erosion could lead to instability of the tunnel.

b. Design and Construction Data. Design drawings dated 1934 indicate the embankment is founded on bedrock and has a reinforced concrete core wall. The core wall is 2 feet wide at the base and tapers uniformly to a width of 1.5 feet. The drawings do not indicate what type of soil was used to construct the embankment.

c. Operating Records. No operating records were made available.

d. Post-Construction Changes. There is no record of any major modifications since construction.

e. Seismic Stability. The dam is located in Seismic Zone 2, and in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection of Storrs Pond Dam indicates that the dam is in fair condition. The inspection revealed the following:

(1) Deterioration of concrete on the spillway and the floor of the discharge tunnel.

(2) No easy means of access to the outlet gate mechanical operator.

(3) Loss of rip-rap protection on the upstream face of the dam.

(4) Several large stumps on the dam.

(5) Brush and cut vegetation on the crest and downstream face of the dam.

(6) Debris in the channel immediately downstream of the dam.

(7) Downstream movement of the left wingwall of the spillway discharge tunnel.

(8) Many fallen trees along the reservoir shoreline, which could clog the spillway opening during high flows.

(9) The crest of the dam was uneven.

The hydraulic analysis reveals that the spillway cannot pass the routed test flood without overtopping the dam.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency. This dam is in generally fair condition. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be accomplished within 1 year after receipt of this Phase I Inspection Report by the owner.

d. Necessity of Additional Investigation. No additional investigation is needed to complete the Phase I inspection.

7.2 Recommendations

The owner should engage a qualified, registered professional engineer to:

(1) Design an acceptable means of removing the tree roots from the dam and backfilling the voids with appropriate material and

(2) Design adequate slope protection for the upstream slope of the dam

(3) Investigate spillway adequacy and consider any modifications if necessary

(4) Design repairs for the concrete deterioration in the invert of the spillway discharge tunnel

(5) Determine an elevation to which the crest of the dam should be evened out

7.3 Remedial Measures

(a) Devise a means of access to the outlet gate operator and maintain the gate in operable condition.

(b) Remove brush and cut vegetation on the crest and slopes of the dam.

(c) Remove debris from the downstream channel.

(d) Prepare a downstream warning system in the event of an emergency.

(e) A technical inspection program should be initiated and continued on a yearly basis. Special attention should be given to the condition of the concrete of the spillway and movement of the left wingwall at the outlet of the discharge tunnel.

(f) Establish a system such that the reservoir level can be monitored during periods of intense rainfall.

(g) Remove fallen trees along the reservoir shoreline.

7.4 Alternatives

There are no practical alternatives to the recommendations of Sections 7.2 and 7.3.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Storrs Pond (Hanover)

DATE 10/26/79

TIME 2:00 PM

WEATHER Cloudy

W.S. ELEV. 406.34 U.S. - DN.S

PARTY:

1. D. LaGatta
2. S. Mazur
3. R. Yarsites
4.
5.
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Dan LaGatta	
2.	Spillway, Outlet and	Stan Mazur	
3.	Downstream Channel	Robert Yarsites	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond Dam DATE 10/26/79

PROJECT FEATURE Embankment Dam NAME

DISCIPLINE Geotechnical Engineer NAME D. P. LaGatta

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	422.69
Current Pool Elevation	406.34
Maximum Impoundment to Date	Unknown.
Surface Cracks	None observed.
Pavement Condition	No pavement.
Movement or Settlement of Crest	Crest is uneven.
Lateral Movement	
Vertical Alignment	No misalignment of embankment observed.
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	Condition at abutment good.
Indications of Movement of Structural Items on Slopes	Wing walls of outlet tunnel portal have moved outward about 2 inches.
Trespassing on Slopes	Footpath on crest.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	Poor. Riprap has been removed in some areas of slope.
Unusual Movement or Cracking at or near Toes	None observed.
Unusual Embankment or Downstream Seepage	None observed. Reservoir had been lowered to repair intake structure.
Piping or Boils	None observed.
Foundation Drainage Features	None.
Toe Drains	None.
Instrumentation System	None.
Vegetation	Excessive vegetation on crest and downstream slope.

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Intake Structure NAME D. LaGatta

DISCIPLINE Geotechnical/Structural NAME S. Mazur

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Intake is a circular concrete drop inlet structure at toe of embankment.
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Intake structure consists of a celindrical, concrete drop-inlet structure. Considerable concrete deterioration was noted.
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Control Tower NAME S. Mazur

DISCIPLINE Structural/Hydraulic NAME R. Yarsites

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Pond drain structure consists of low inlet located at left side of circular spillway and is operated by gate. The gate is operated from the crest of the spillway. Mechanical controls and gate are very rusty.
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Pond Drain Structure NAME

DISCIPLINE Structural/Hydraulic NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	The pond is drain by a low inlet and concrete tunnel through the dam. See Figure 1. General condition Fair.
Rust or Staining on Concrete	Rust and stainy.
Spalling	Spillway-walls and slab of spillway tunnel.
Erosion or Cavitation	Erosion of bottom slab and under walls.
Cracking	Cracking-walls & slab.
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Spillway Tunnel NAME R. Yarsites, S. Mazur

DISCIPLINE Hydraulic,Structural, Geotechnical NAME D. LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Fair condition - low inlet and spillway tunnel.
Rust or Staining	Staining all walls.
Spalling	Spalling walls and bottom slab.
Erosion or Cavitation	Erosion - slab & walls.
Visible Reinforcing	None noted.
Any Seepage or Efflorescence	Efflorescence all walls.
Condition at Joints	Good, some spalling.
Drain Holes	None.
Channel	
Loose Rock or Trees Overhanging Channel	Large trees overhanging.
Condition of Discharge Channel	Poor. Much debris collected on banks.

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Spillway Structure NAME S. Mazur, R. Yarsites

DISCIPLINE Structural/Hydraulic/Geotechnical NAME D. LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Drop inlet structure passes excessive flow.
Loose Rock Overhanding Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Fair.
Rust or Staining	Staining walls.
Spalling	Spalling walls.
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel	Same as outlet channel.
General Channel	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Channel	
Other Obstructions	

PERIODIC INSPECTION CHECK LIST

PROJECT Storrs Pond DATE 10/26/79

PROJECT FEATURE Service Bridge NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	This facility has no service bridge. However, the remains of a catwalk from the dam crest to the spillway riser could be seen.
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

1. LIST OF DESIGN, CONSTRUCTION AND MAINTENANCE RECORDS
2. PAST INSPECTION REPORTS
3. PLAN AND DETAILS

AVAILABLE ENGINEERING DATA

1. A set of drawings (3 sheets), dated November 1934, showing the dam and appurtenant structures is on file at the New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire.

PAST INSPECTION REPORTS

M E M O

Date: November 28, 1978

To: Vernon A. Knowlton,
Chief Engineer

From: Gary L. Kerr,
Water Resources Engineer

B-1

Subject: Dam Inspection (No. 108.07) Storrs Pond Dam in Hanover
Date of Inspection: November 9, 1978

I submit the attached folder with the field inspection report relating to my site visit of November 9, 1978. The following items of maintenance or repair deserve appropriate and timely action to insure stability of the structure:

1- Trees and bushes are growing on the embankment and need to be removed to prevent damage to the dam by the root structure or by the tree being entirely uprooted.

2- The downstream wingwalls are cracked and spalled and need to be properly repaired to prevent potential failure.

3- The exterior surface of the concrete riser (above the present pond level) near the permanent crest has received some maintenance as evidenced by the still attached formwork, but may require more attention as some areas still show areas of spalling.

4- The access walkway from the dam embankment out to the concrete riser does not appear to be sturdy enough to support foot traffic as one of its supports is broken near the present waterline.

A letter to the owner indicating that the above items are required maintenance is being sent. This dam is a menace due to the pond storage and the State Highway (Route No. 10). Its discharge then flows into the reservoir behind Wilder Dam.

GLK:paf
Enc.

NEW HAMPSHIRE WATER RESOURCES BOARD

B-2

INSPECTION REPORT

Town: [illegible] Dam Number: [illegible]

Name of Dam, Stream and/or Water Body: [illegible]

Owner: [illegible] Telephone Number: 643-2409

Mailing Address: [illegible]

Max. Height of Dam: 34 Pond Area: [illegible] Length of Dam: 135'±

FOUNDATION: [illegible]

OUTLET WORKS: [illegible]

ABUTMENTS: NONE

EMBANKMENT: [illegible]

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 50.5 ± Freeboard: 4 ±

SEEPAGE: Location, estimated quantity, etc.

B-3

V/ SLIGHT DAMP SPOT ON D/S FACE

Changes Since Construction or Last Inspection:

GENERAL DETERIORATION, PENDING SOME MINOR REPAIRS TO THE CONCRETE

Tail Water Conditions:

RES # 10, BACKWATER OF WHITE DAM

Overall Condition of Dam: FAIR

Contact With Owner: NO

Date of Inspection: 9 Nov 78 Suggested Reinspection Date

Class of Dam: MEDIUM

Signature Gary L Koon

Date 9 Nov 78

Note: Give Sizing, Condition and detailed description for each item, if applicable.

Dam No.______________

B-4

COMMENTS:

1) TREES & BRUSH [illegible] EMBANKMENT

2) CRACKING AND SPALLING OF [illegible] D/S WINGWALLS

3) OUTLET CHANNEL IS LINED WITH CONCRETE - THE CONCRETE HAS PARTIALLY [illegible]

4) OUTLET TUNNEL WALLS HAVE CALCIUM DEPOSITS BUILDING UP AT MOST OF THE CONSTRUCTION JOINTS.

5) EXTERIOR OF RISER APPEARS TO HAVE HAD ATTEMPTED REPAIRS (SEE PHOTO) FOR [illegible] AND SPALLING

6) POND LEVEL ~ 6" FROM TOP OF [illegible]

7) ACCESS WALKWAY DOES NOT APPEAR TO BE SAFE

NEW HAMPSHIRE WATER RESOURCES BOARD

B-5

INSPECTION REPORT

Town: Hanover Dam Number: 109.07

Name of Dam, Stream and/or Water Body: Storrs Pond

Owner: Hanover Improvement Society Telephone Number:

Mailing Address:

Max. Height of Dam: 35' Pond Area: Length of Dam: 140'

FOUNDATION: Earth Foundation

OUTLET WORKS: 10' I.D. Drop inlet spillway,
3' dia waste Gate

ABUTMENTS:

EMBANKMENT: Earth Embankment 2:1 upstream 1:1 downstream
Trees need to be cut

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 10' Dia Freeboard: 6'

SEEPAGE: Location, estimated quantity, etc.

B-6

None

Changes Since Construction or Last Inspection:

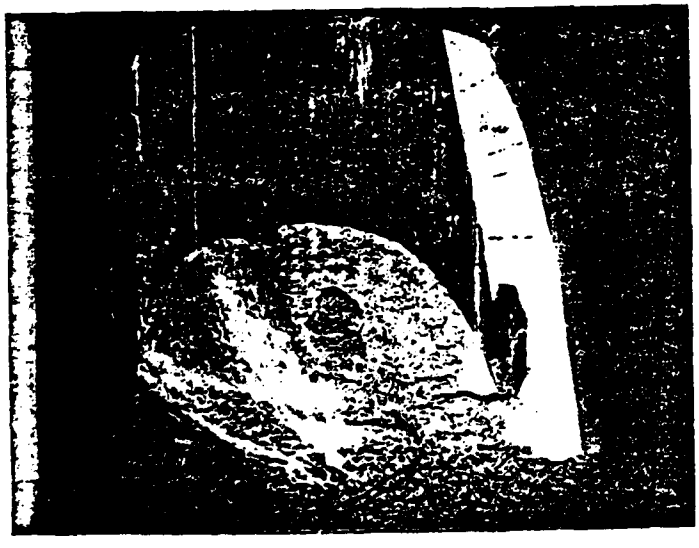
Tail Water Conditions:

Overall Condition of Dam: Fair

Contact With Owner: No

Date of Inspection: 23 May 77 Suggested Reinspection Date 1980

Class of Dam: Menace A



Signature J Barnett

Date

Note: Give Sizing, Condition and detailed description for each item, if applicable.

Dam No. B-7

COMMENTS:

Concrete on Top of Spillway needs to be repaired.

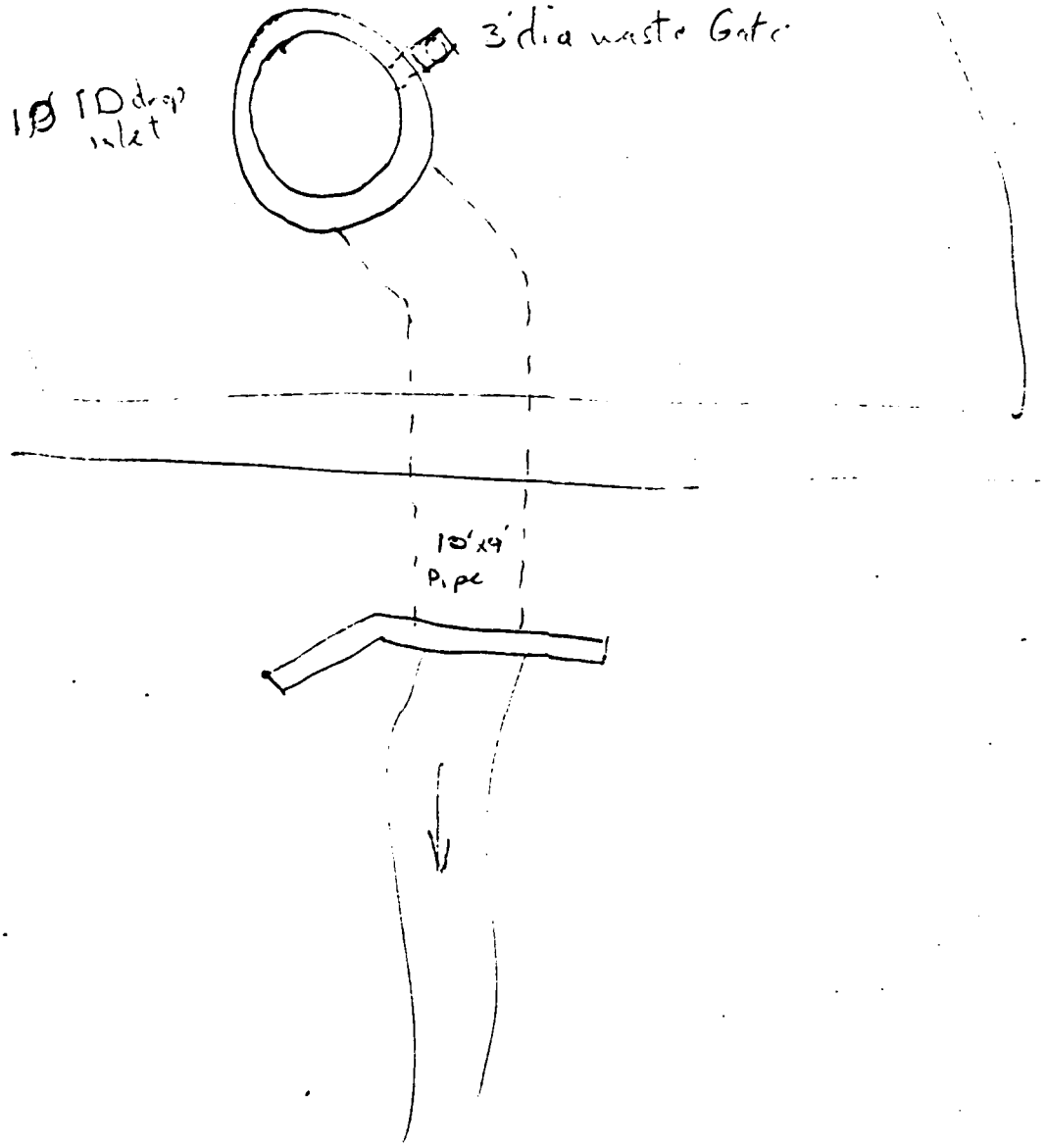
Trees on Embankment

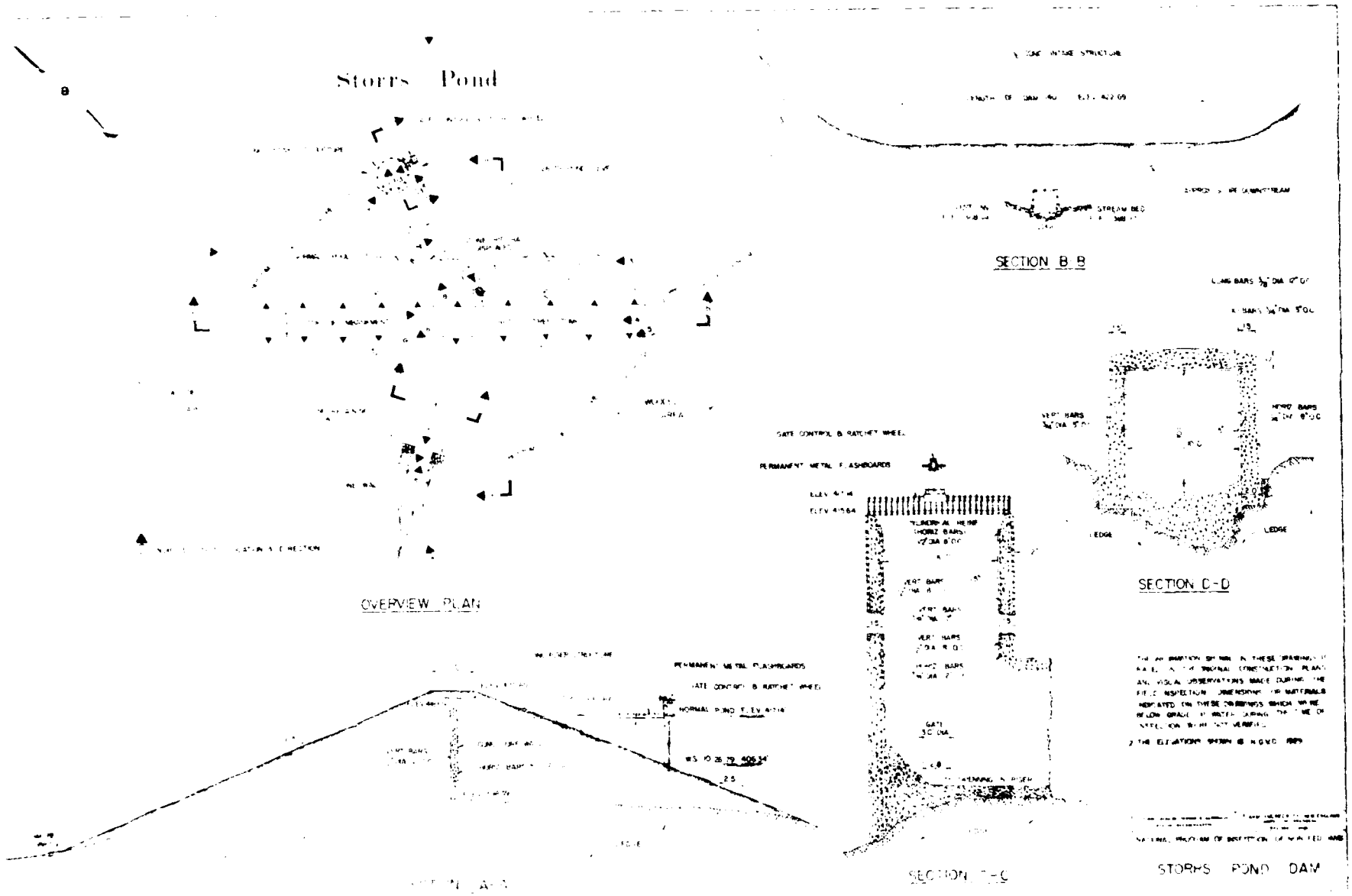
Concrete on Intern Floor of discharge tunnel needs repair

Dam No. _____

B-8

SKETCH OF DAM (Show Plan, Elevation & Cross Sections)




Storrs Pond
OVERVIEW PLAN
SECTION B-B
SECTION C-D
STORRS POND DAM

APPENDIX C

PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE 1
LOCATED IN APPENDIX B

PHOTO NO. 1 - View of reservoir from dam.

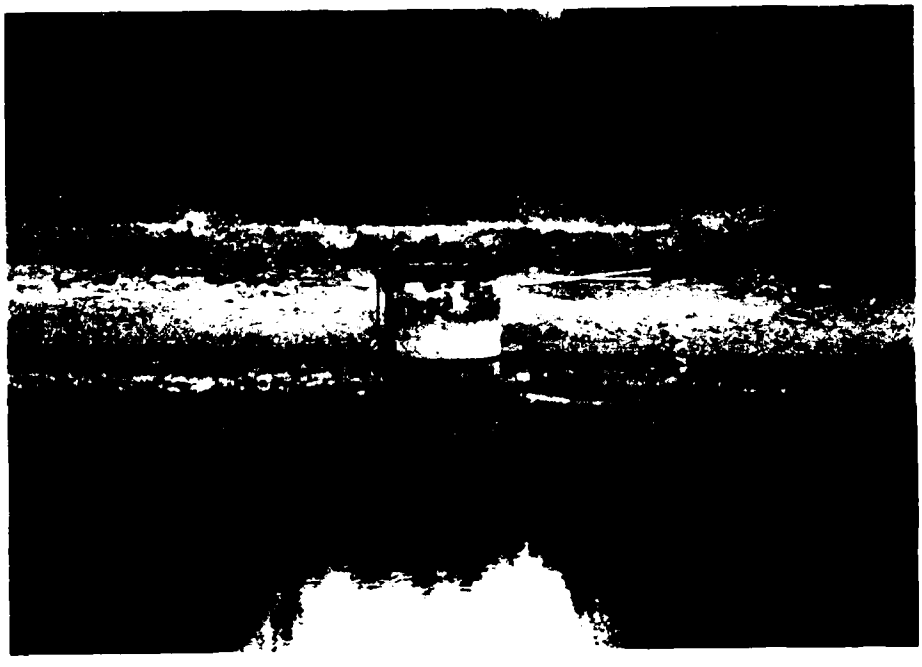


PHOTO NO. 2 - Upstream face of dam from shoreline opposite dam.

PHOTO NO. 3 - Upstream face from left abutment. Note areas of missing rip-rap.

PHOTO NO. 4 - Crest as seen from left abutment.

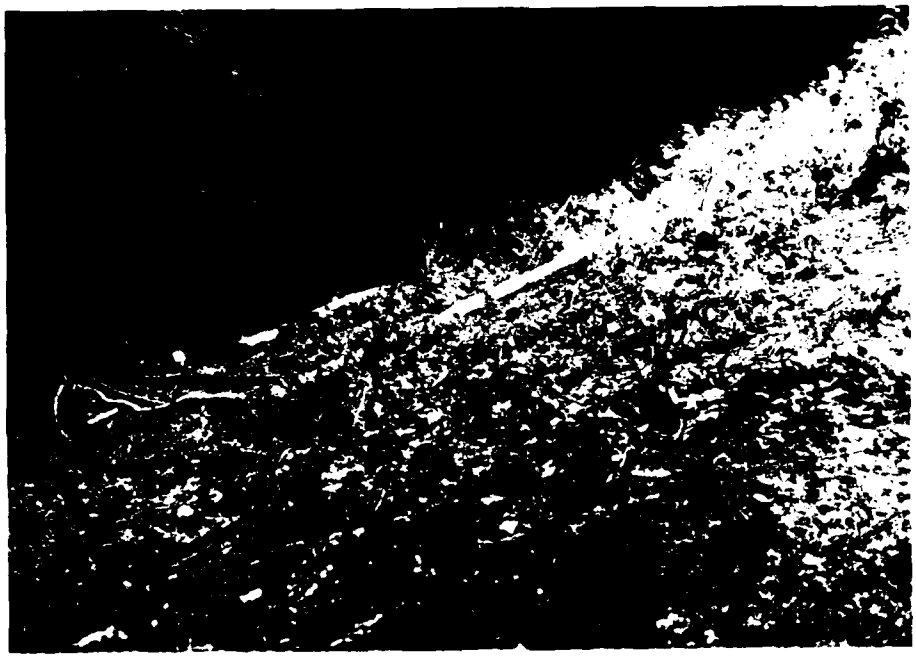


PHOTO NO. 5 - Downstream face as seen from left abutment.

PHOTO NO. 6 - Rotting tree stump on downstream face 1 to 2 feet below the crest.

PHOTO NO. 7 - Rotted tree stump on upstream face of dam.

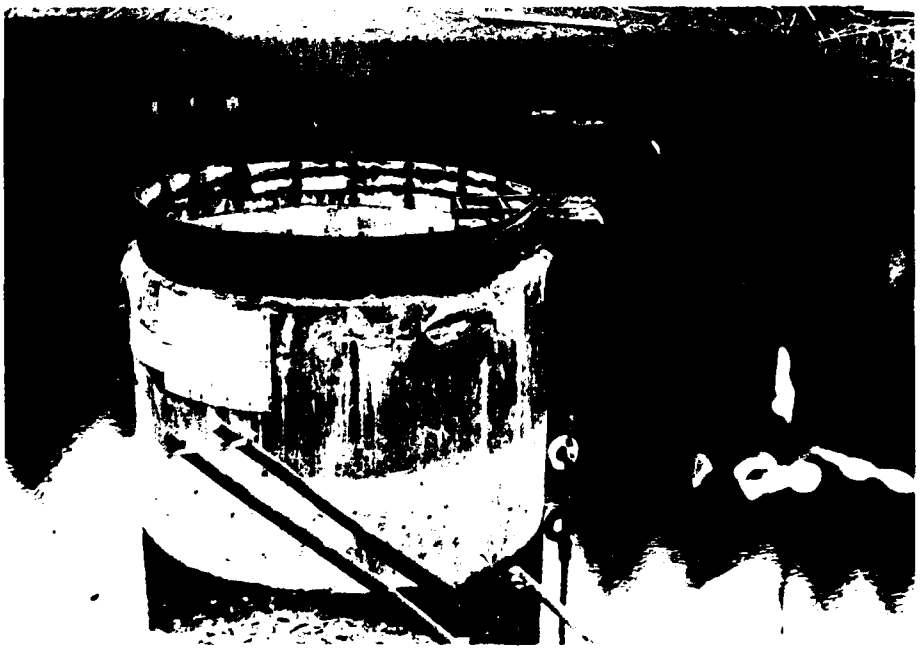


PHOTO NO. 8 - Spillway crest and upper portion of riser.

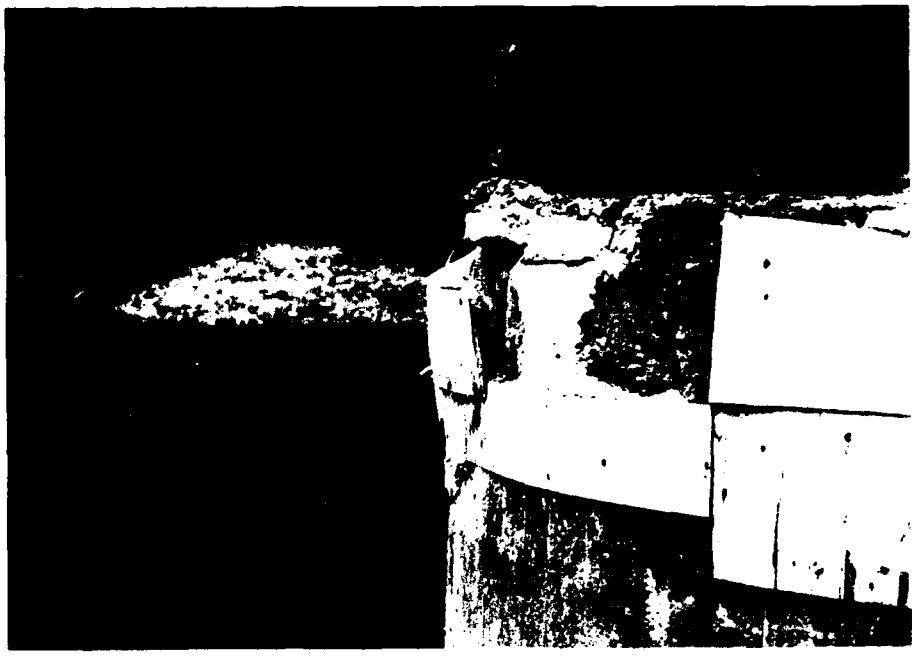


PHOTO NO. 9 - Detail of concrete spillway. Note plywood patch forms.

PHOTO NO. 10 - Detail of concrete spillway. Note patch and cracking.

PHOTO NO. 11 - Upstream face of dam as seen from right abutment. Note remains of catwalk to the spillway.

PHOTO NO. 12 - Inside of spillway as seen from invert of discharge tunnel.

PHOTO NO. 13 - Outlet gate in spillway riser.

PHOTO NO. 14 - Heavy efflorescence on wall of spillway discharge tunnel.

PHOTO NO. 15 - Downstream portal of spillway discharge tunnel.

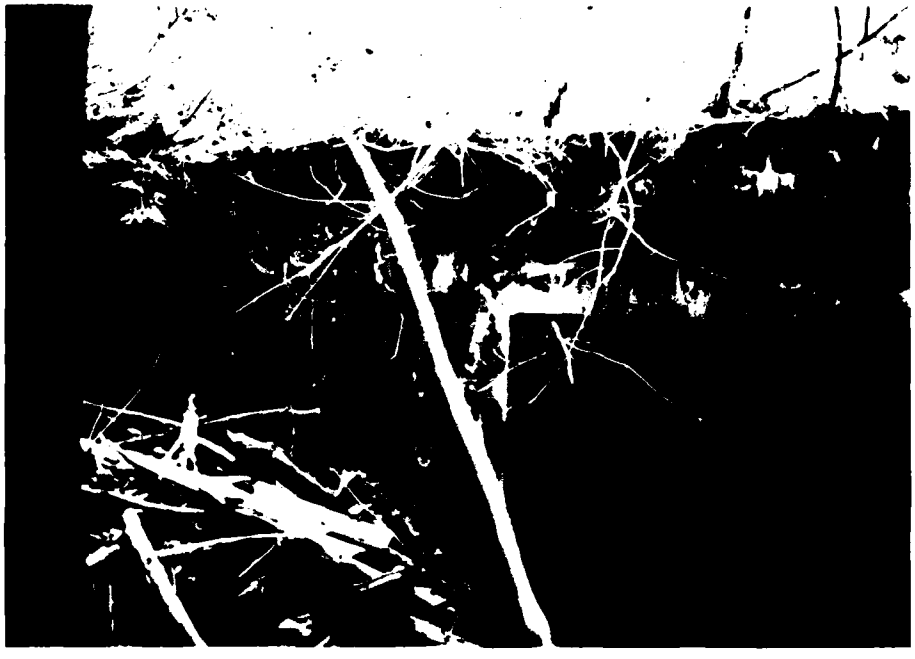


PHOTO NO. 16 - Detail of right retaining wall of the tunnel outlet.

PHOTO NO. 17 - Left wingwall of the tunnel outlet. Note movement of wall.

PHOTO NO. 18 - Spillway and outlet channel viewed from tunnel portal.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/13/79	Job No 965-11-15
	Checked by HM	Date 20 NOV 79	Sheet No. 1
For STORRS POND DAM			

HYDRAULICS & HYDROLOGY

Storrs Pond Dam is located along Camp Brook about 1000 feet upstream of the Connecticut River in Hanover, Grafton Co., New Hampshire.

Classification

Size: Small
Hazard: Significant

Basic Data

Drainage Area: 2.74 mi²
Max Elev. 1280 FT. MSL
Mountainous 300 ft/mi
D.A.: 2 upstream reservoirs 1.86 sq mi to Lower Res.

Reservoir: Surface Area 34 acres
Crest Elev.: 422.69 Stor.: 520 acre ft
at time of inspec
Spillway w/fence": 417.14 " 350 acre ft
Spillway crest": 415.64 " 300 acre ft

Dam Earth
140 ft long w/ core wall
33.75 ft high

Spillway - 10'ϕ drop inlet
10x10 outlet box culvert
Permanent + flashboards 1.5 ft

Pond Drain 3' dia gate slide type
in front of hexagonal opening.
2.8 ft across

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/13/79	Job No. 5965-11-15
	Checked by HM	Date 11/26/79	Sheet No. 2
For Storrs			

Step 1 Calculation of Test Flood Inflow

Classification Size Small
Hazard Significant

Hydrologic Evaluation Guideline Recommends

100 yr Frequency flood to ½ PMF for Test Flood Inflow

Use ½ PMF as size is in upper range of height class with 34 feet vs a maximum range value of 40 feet.

Use mountainous curve as there is a steep tributary 300± feet/mile slope.

There are two dams in the watershed upstream of Storrs Pond the lower of the two: Lower Reservoir Dam has a tributary area of 1.86 mi². This leaves .88 sq mi directly tributary to Storrs Pond

The Test flood inflow to Lower Reservoir is 2345 cfs

The Routed test flood outflow is ------ 1860 cfs
as shown in calculations on page
2-2 thru 2-5

Flow direct to Storrs Pond
½ x 2450 x .88 = ---------- 1080

Total Inflow to Storrs Pond 2940 cfs

HNTB	Made by RY	Date 11/13/79	Job No. 5955-11-15
HOWARD NEEDLES TAMMEN & BERGENDOFF	Checked by HM	Date 11/26/79	Sheet No. 3
For Storr's			

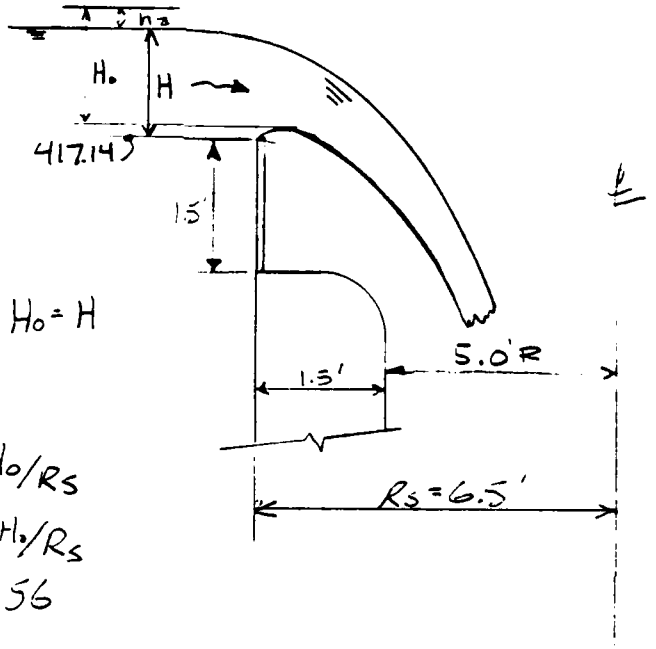
Step 2 Calculation of Surcharge

Consider: No flow thru pond drain pipe
Permanent Flashboards to elev. 417.14

Spillway discharge

Crest Control

17' ϕ inside crest
13' ϕ outside
$Q = C_o 2\pi R_s H_o^{3/2}$



Assume $H_o = H$

see attached sheet for
C_o* as determined by H_o/R_s
Max value considered of H_o/R_s
is 424.7 − 417.14 = 7.56
$7.56/6.5 = 1.16$

H_o (FT.)	H_o/R_s	C_o	Q_{crest}
1	.15	4.0	163 cfs
2	.31	3.73	431 "
4	.62	3.07	1003 "
6	.92	2.20	1320 "
8	1.23	1.65	1525 "
5.55	.85	2.33	1244 "

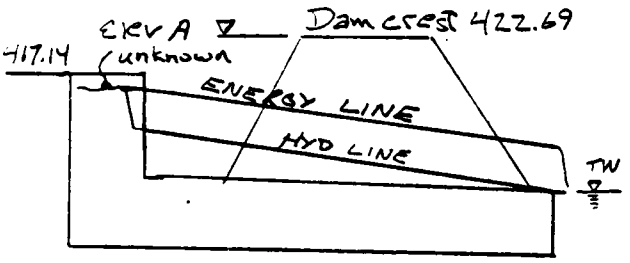
Check for control in outlet Tunnel
Conduit = 10 foot x 10 foot section under dam
$S_o = 3.2'/103' = .03107$ ft/ft
$n = 0.018$ high to include minor losses
Q at crest of dam 1244 cfs, will flow

* 2e Design of Small Dams by S.C.S.

D-3

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/26/79	Job No. 5965-11-15
	Checked by HM	Date 11/26/79	Sheet No. 4
For Storrs			

Check to see if outlet will control if water surface in reservoir is at the crest of dam and through the discharge tunnel with a weir flow of 1244 cfs. If elevation A is calculated to be at the crest of the riser or above outlet will control flow



Compute slope of energy line

$$S_f = \frac{V^2 n^2}{2.22 R^{4/3}} = \frac{12.44^2 \times .018^2}{2.22 \times 2.5^{4/3}} = .0066 ft/ft$$

$S_f < S_o$ therefore the hydraulic grade line will be below the top of the conduit and the elevation A will be well below the riser crest.
Inlet controls.

Discharge over Dam Crest

$Q = CLH^{3/2}$ $C = 3.08$ $L = 140'$ $H = H_o - 5.55 ft$

$Q = 431.2 H^{3/2}$

Stage-Discharge Curve see fig 1

Elev	H_o	$Q_{spillway}$	H	Q_{dam}	Q_{Total}
418.14	1	163 cfs	-		163 cfs
419.14	2	431	-		431
421.14	4	1003	-		1003
423.14	6	1320	.45	130 cfs	1450
424.14	7	1422	1.45	753	2175
425.14	8	1525	2.45	1654	3179

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/13/79	Job No. 5765-11-15
	Checked by HM	Date 11/26/79	Sheet No. 5
For Storrs			

Step 3 Calculation of Surcharge Effect

Q_{P_1} = 2940 cfs R.O. 9.5 inches

Storage above spillway crest vertical prism (417.14)

Start routing with water surface at elev 417.14

$$Q_{P_2} = Q_{P_1} \times \left(1 - \frac{Stor_{(in)}}{9.5}\right)$$

$$Stor_{(in)} = \frac{Stage\ ft \times 34\ acre \times 12\ in/ft}{640\ acre/mi^2 \times 2.74\ mi^2} = .23\ Stage$$

Routing Curve see Fig 1

Elev	Stage	$Stor_{(in)}$	Q_{P_2}
420.14	3	.70	2720 cfs
421.14	4	.93	2650
422.14	5	1.16	2580
423.14	6	1.40	2510
424.14	7	1.63	2440

See figure 1 for Outflow 2420 cfs
Stage 7.37 ft
elev 424.51
Overtopped by 1.82 ft

Spillway at top of dam 1244 cfs 51% of Control TF
Spillway at TF 1360 cfs

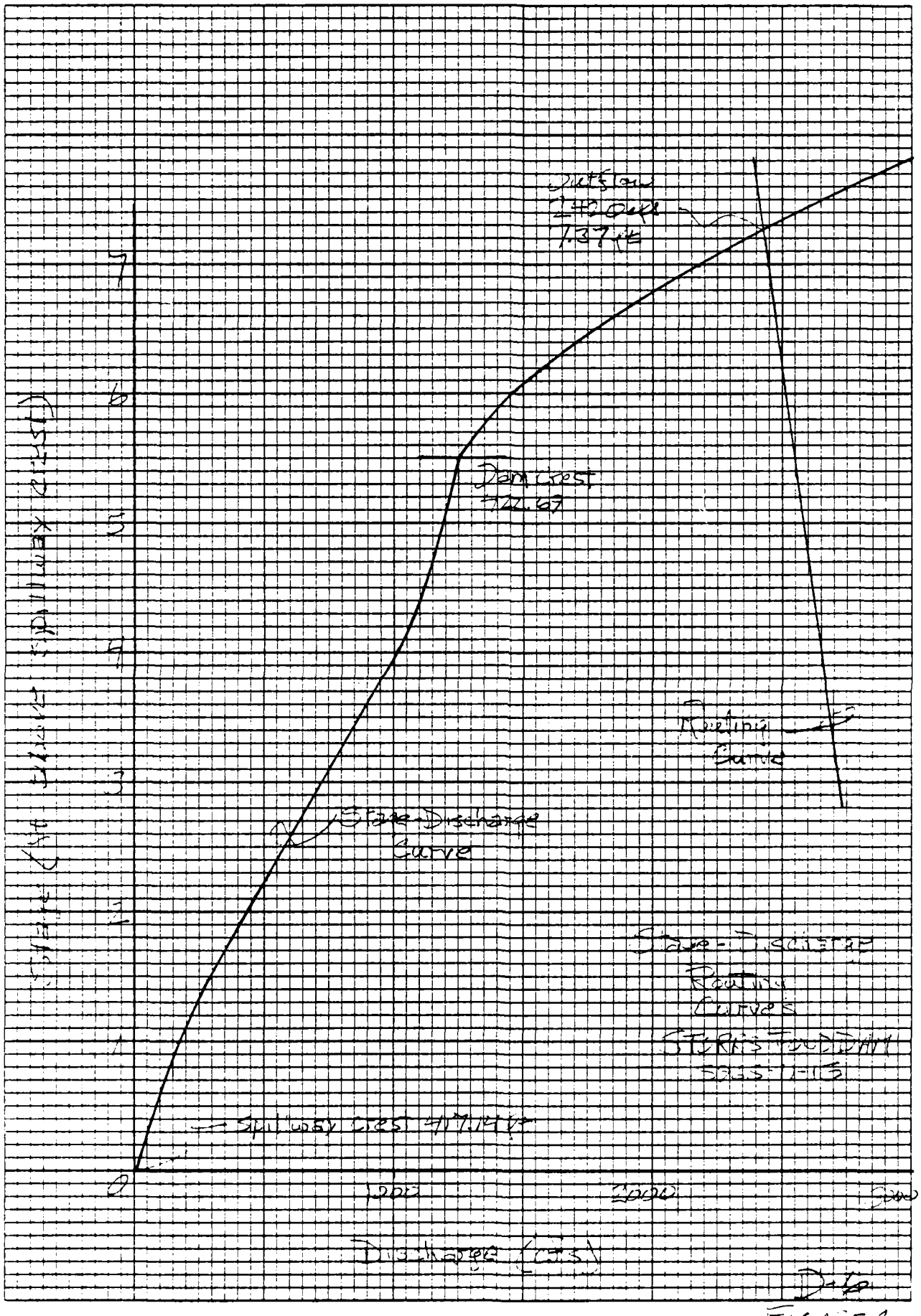


Figure 1

10x10 TO THE INCH

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/12/79	Job No 5965-11-13
	Checked by HH	Date 11/26/79	Sheet No 2-2
For Lower Reservoir For Inflow to Storrs Pond			

Step 1 Calculation of Test Flood Inflow.

Classification : Size : small
hazard : significant

Hydrologic Evaluation Guideline Recommends

100 yr Frequency flood to ½ PMF for Test flood inflow

Use ½ PMF as size is on higher end of classification range. 823 acre-ft vs. a maximum of 1000 a-f and a height of 33 feet vs. a maximum of 40 ft.

Use mountainous curve as there is a steep tributary area. As drainage area is 1.83 sq mi outside of the PMF guide curve envelope use the maximum PMF value of 3000 csm

Upper Reservoir has a tributary area .83 sq mi of the watershed with 1.03 sq mi directly tributary to Lower Reservoir

Test flood inflow to Upper Res

½ × 3000 × .83 = 1245 cfs

Routed test flood outflow - 780 cfs
*See calculations at the end of this section pg 2-2 to 2-5
Not included in this text.

Test flood inflow direct to Lower Reservoir

½ × 3000 × 1.03 = 1545 cfs

Upper Reservoir Outflow	780 cfs
Inflow direct to Lower Res	1545 cfs
Total inflow to Lower Reservoir	2325 cfs

D-7

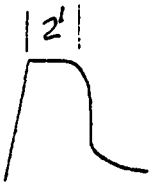
HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RV	Date 11/13/19	Job No. 5965-11-13
	Checked by HM	Date 11/26/19	Sheet No. 2-3
For LOWER Reservoir for Inflow to Storrs Pond			

Step 2 Calculation of Surcharge Effect

Consider: No significant flow thru the water supply intakes or pond drain.

: No flashboards in place (1.0 ft high)

Spillway Discharge weir $Q = CLH^{3/2}$



$C = 3.25$

$L = 33'$ across weir crest

Permanent crest elev 708.0

$Q = 3.25(33)H^{3/2} = 107.25H^{3/2}$

Discharge over dam crest $Q = CLH^{3/2}$

$C = 3.08$

Crest Elev 711.5

$L = 1023 - 33 = 990$ ft

$Q = 3.08(990)(H-3.5)^{1.5} = 3049.2(H-3.5)^{1.5}$

Stage-Discharge see fig 1

Elev	H	Qspillway	QDam	Total	
708	0	-	-	0 cfs	
709	1 ft	110 cfs		110	
710	2	300		300	
711	3	560		560	
711.5	3.5	700		700	
711.6	3.6	730	100 cfs	800	
711.8	3.8	790	500	1290	
712.0	4.0	860	1080	1940	D-8
712.2	4.2	920	1790	2710	

101-37

HNTB	Made by RY	Date 11/13/79	Job No. 5965-11-13
HOWARD NEEDLES TAMMEN & BERGENDOFF	Checked by HM	Date 11/26/79	Sheet No. 2-4
For LOWER Reservoir For Inflow to Storrs Pond			

Step 3 Calculation of Surcharge Effect

Q_{P_1} = 2325 cfs RO = 9.5 inches

Storage above spillway crest vertical prism Lakes surface 47A

Start routing with water surface at spillway crest.

$$Q_{P_2} = Q_{P_1} \times \left(1 - \frac{Stor_{(in)}}{9.5}\right)$$

$$Stor_{(in)} = \frac{\text{Storage in AF} \times 12\ in/ft}{640\ \frac{acre}{mi^2} \times 1.86\ mi^2} = 0.0101\ Stor\ A\text{-}F$$

Routing Curve See Fig 1

Elev	Storage	Stor(in)	Q_{P_2}
708	0		2325 cfs
709	47 acre-ft	.47 in	2210
710	94	.95	2090
711	141	1.42	1980
712	188	1.90	1860
713	235	2.37	1740

37

See Fig 1 for outflow 1860 cfs

Stage 712.0 ft
0.50 ft above dam

Spillway 38% of Routed test flood outflow

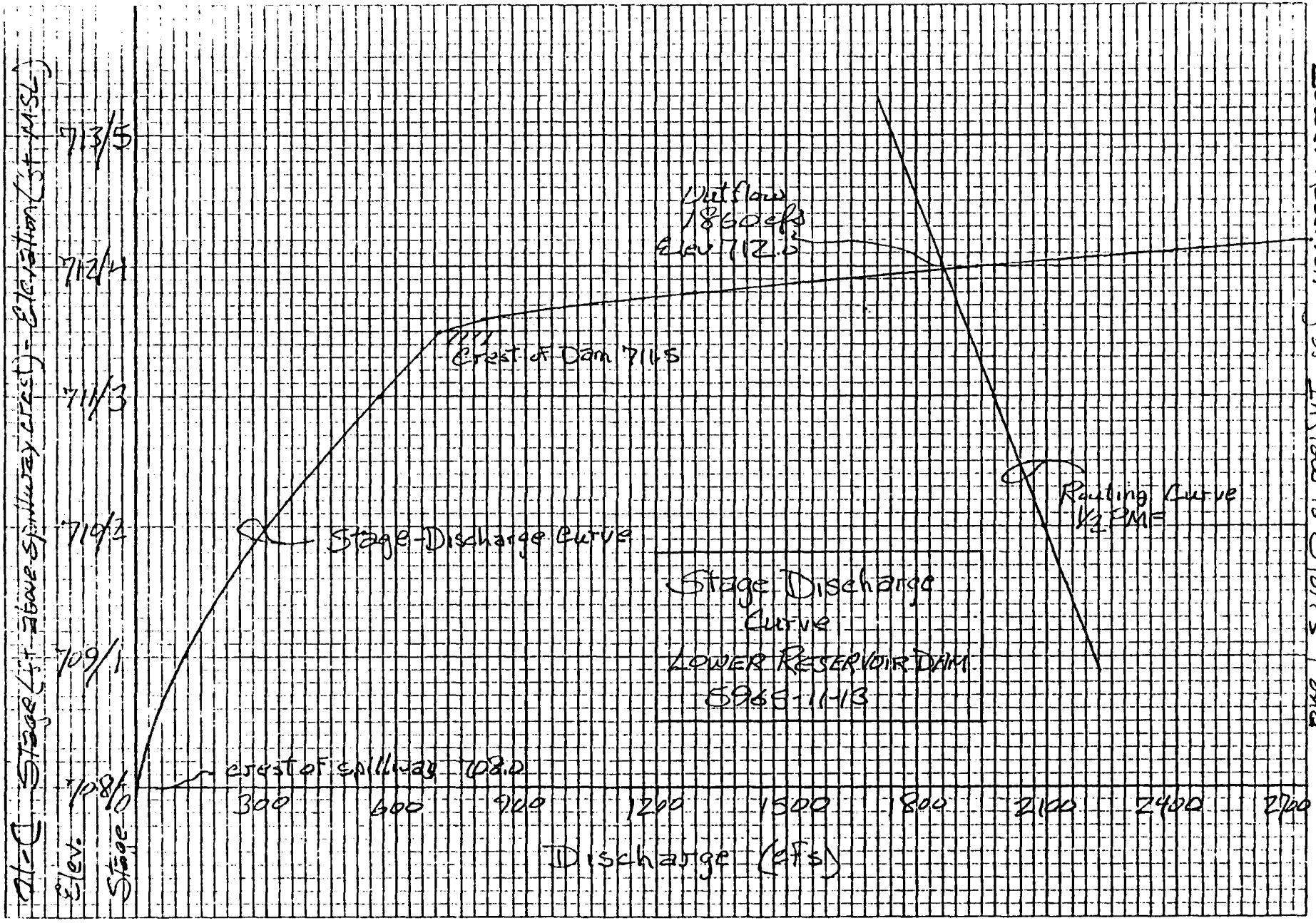


FIGURE 1

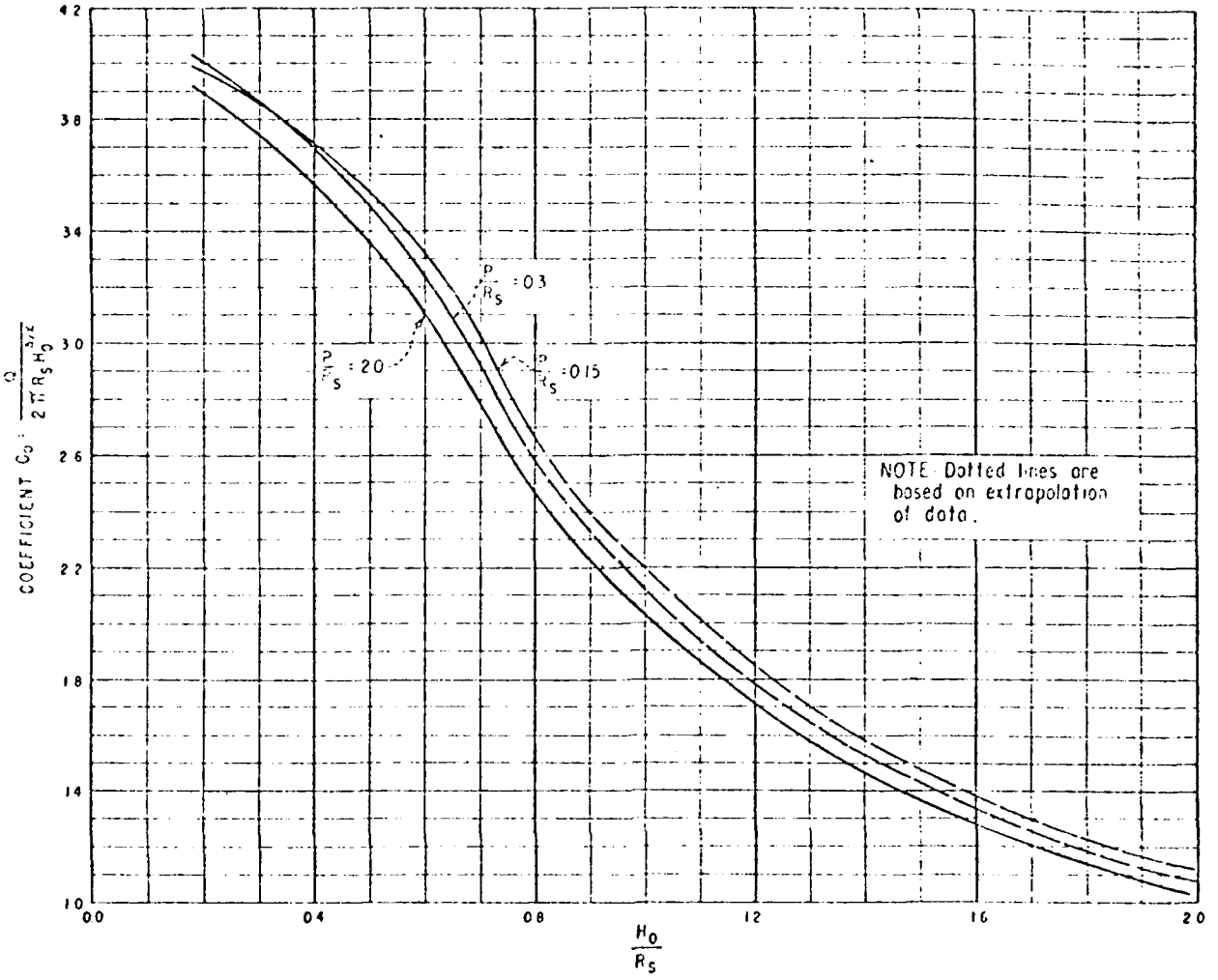


Figure 283. Relationship of circular crest coefficient C_o to $\frac{H_o}{R_s}$ for different approach depths (aerated nappe) 288-D-2441.

Ref: Design of Small Dams
U.S. Dept. of Interior
Bureau of Reclamation

For: Morning Glory Type Drop Inlet

D-11

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/14/79	Job No. 5965-11-15
	Checked by AM	Date 11/26/79	Sheet No. 6
For STORRS			

DOWNSTREAM DAMAGE ASSESSMENT

Step 1 Reservoir Storage

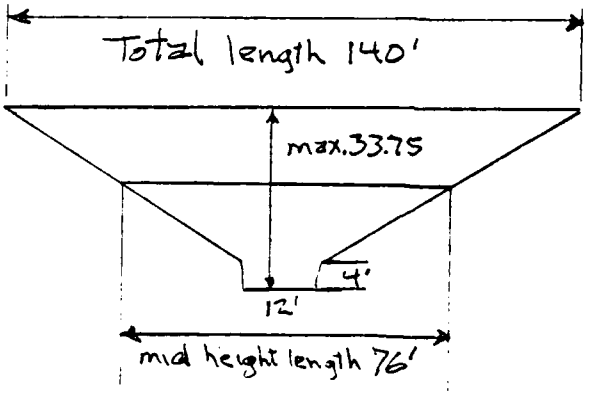
Top of Dam Elev. 422.69 Storage 520 acre ft

Step 2 Breach Outflow

$$Q_{Breach} = 8/27 \sqrt{g}\, W_o\, Y_o^{2/3}$$

W_o = 40% of dam length at Mid Height

Y_o = maximum height Top of dam to streambed



$$Q_{breach} = 8/27 \sqrt{g}(.40)(76)(34)^{3/2} = 10100 \text{ cfs}$$

As spillway outlet is located in center of dam. Its discharge will be included with the breach wave

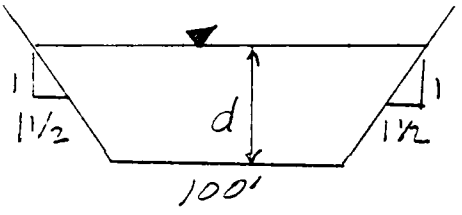
HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/14/79	Job No 565-11-15
	Checked by HM	Date 11/26/79	Sheet No. 7
For Storrs			

Step 3 Stage Discharge

Reach Length 1000 ft

The outflow of the downstream reach is controlled by the Route 10 highway embankment. The waterway opening under Route 10 was not visible. It is assumed that the discharge thru this openning would be negligible under breach flow conditions

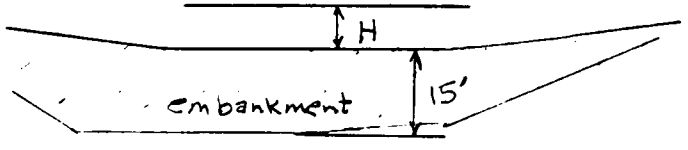
Valley Storage between Storrs Pond Dam and Route 10 is computed with the cross section shown below.



Valley X-section

The Route 10 embankment is 15 ft above the streambed Thus d is equal to H (the depth of flow over the roadway embankment) + 15 feet

Route 10 profile



H = water surface upstream of embankment

Assume horizontal weir crest 300'

$Q = CLH^{3/2}$ $C = 3.08$

Stage (H)	Discharge
1 ft	720 cfs
2	2600
3	4800
4	7400
5	10,300

D-13

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by RY	Date 11/14/79	Job No. 5965-11-15
	Checked by HM	Date 11/26/79	Sheet No. 8
For Storrs			

Step 4 Reach Outflow

$Q_{P_1} = 10{,}100$ cfs

$S = 520$ acre ft
$L = 1000$ ft

Stage, $H = 4.92'$ $d = 19.92'$

$A = 2590$ ft²

$$V_1 = \frac{2590 \times 1000}{43560} = 59.5 \text{ acre-ft}$$

$$Q_{P_{2_T}} = 10{,}100\left(1 - \frac{59.5}{520}\right) = 8940 \text{ cfs}$$

Stage, $H = 4.5'$ $d = 19.5'$ $A = 2520$ ft²

$$V_2 = \frac{2520 \times 1000}{43560} = 57.9 \text{ acre-ft}$$

$V_{ave} = 58.70$

$$Q_{P_2} = 10{,}100\left(1 - \frac{58.7}{520}\right) = 8960 \text{ cfs}$$

Stage $H = 4.5$ ft depth of water above Route 10

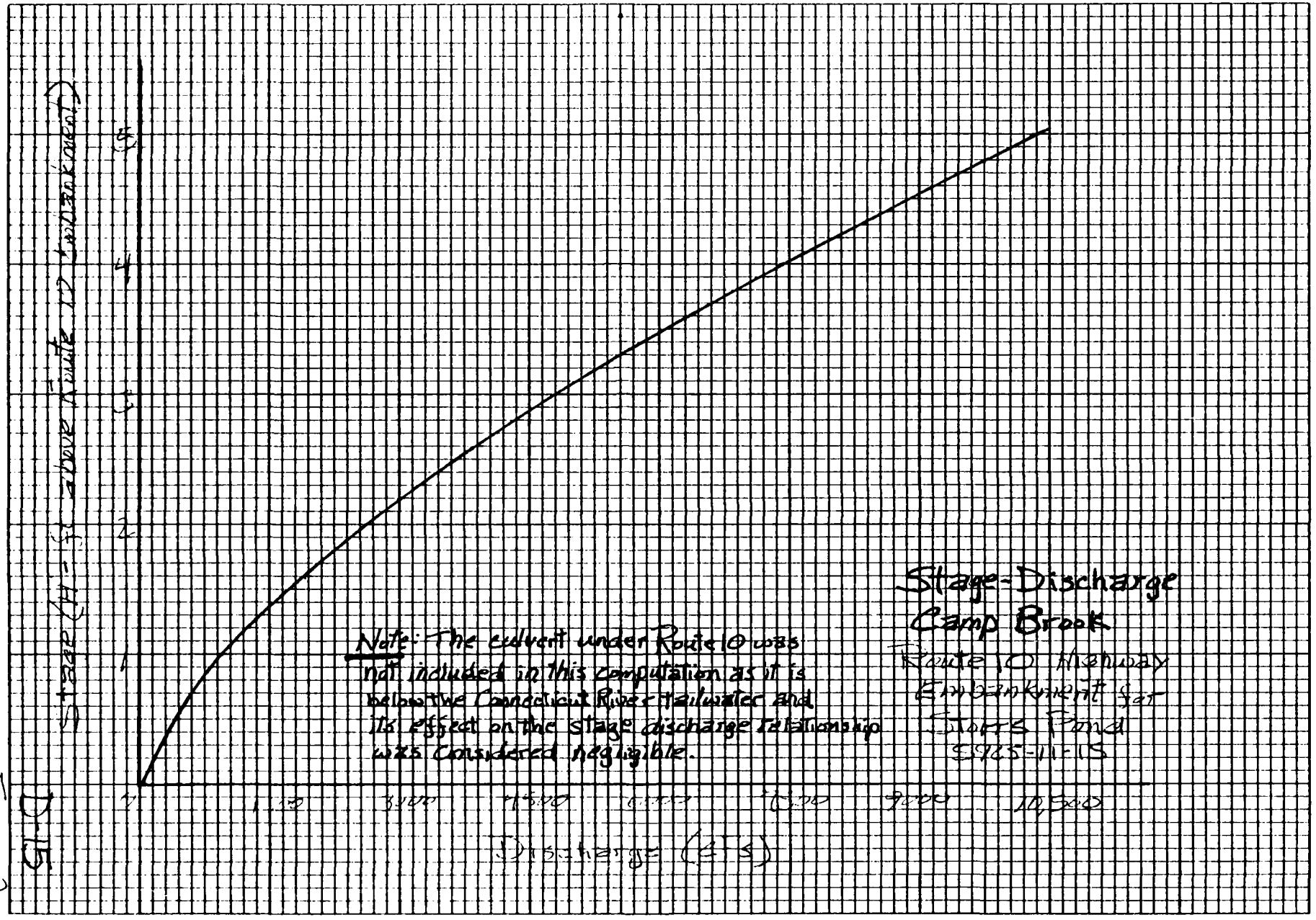
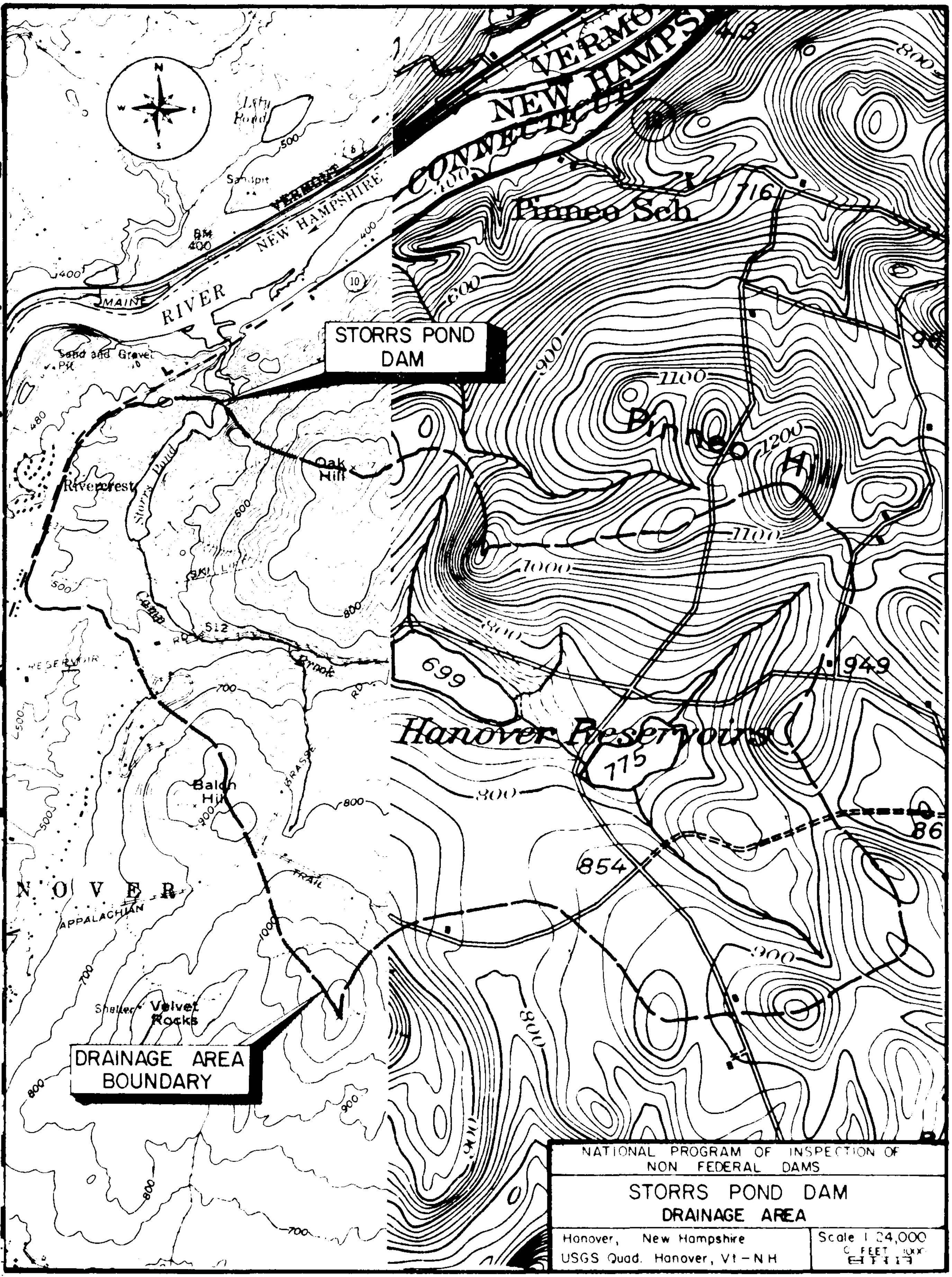


Figure 2

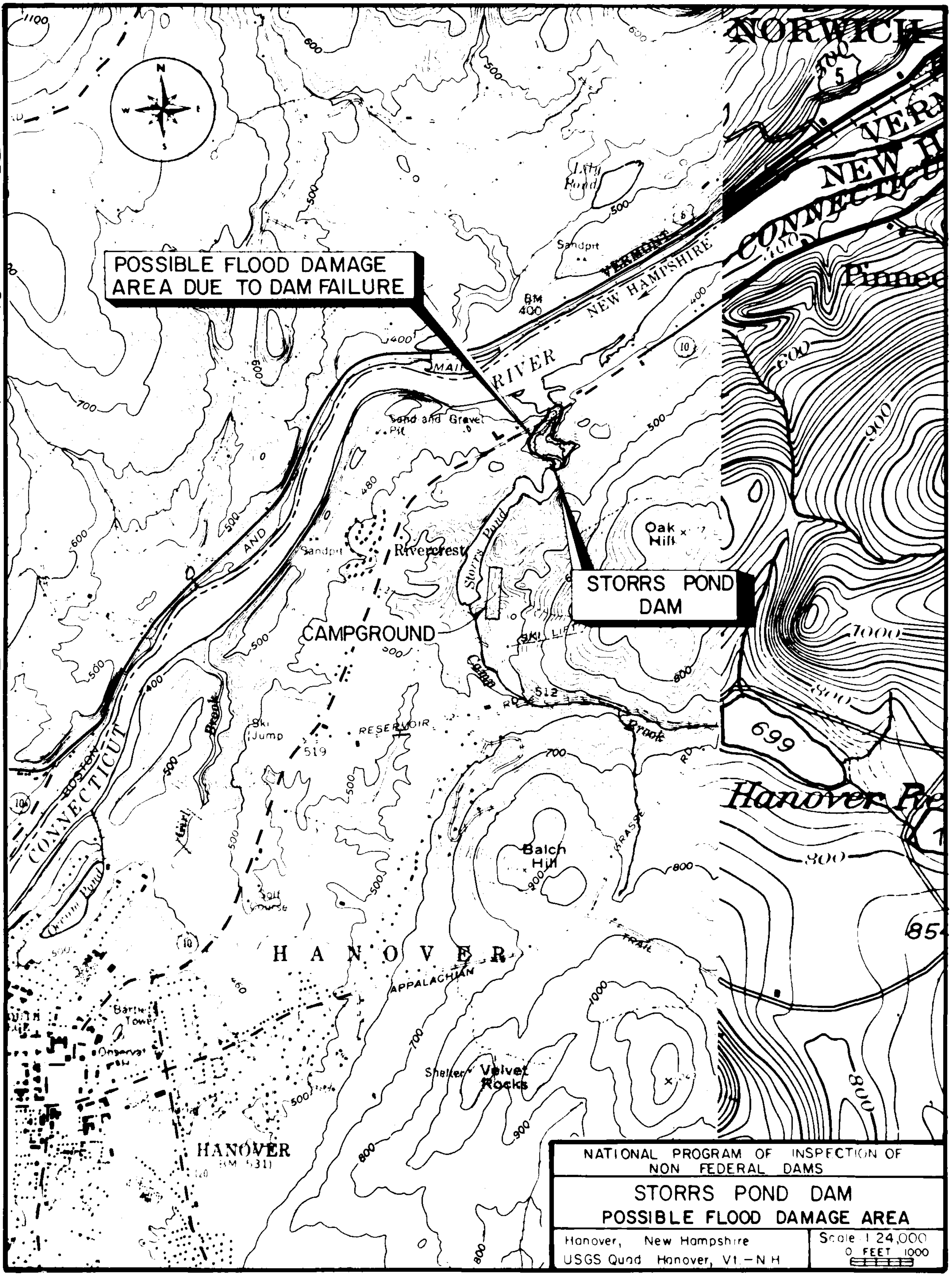


NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS

STORRS POND DAM
DRAINAGE AREA

Hanover, New Hampshire
USGS Quad. Hanover, Vt - N H

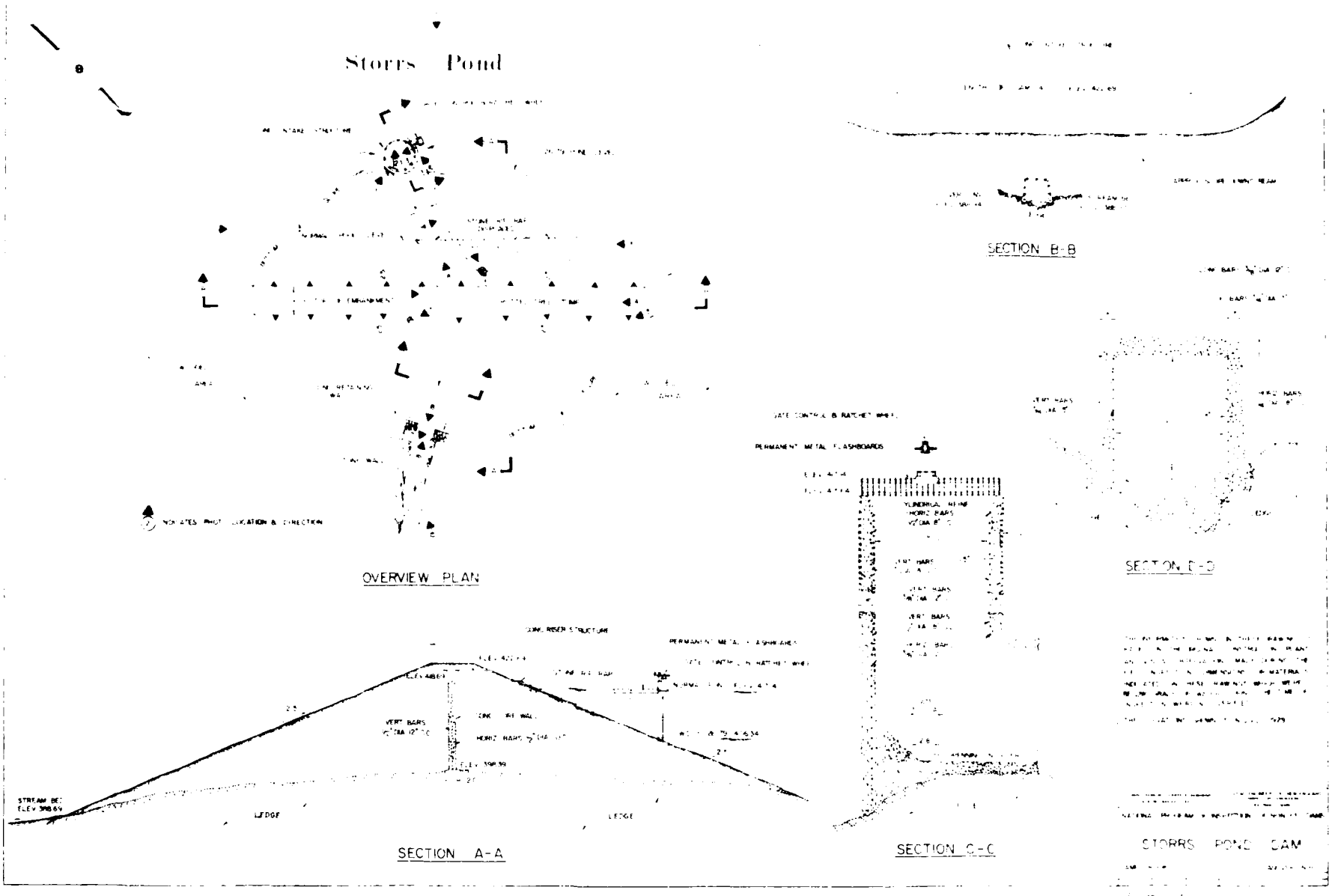
Scale 1:24,000



POSSIBLE FLOOD DAMAGE
AREA DUE TO DAM FAILURE
STORRS POND
DAM
NORWICH
VERMONT
NEW HAMPSHIRE
CONNECTICUT
RIVER
Lily Pond
Sandpit
BM 400
Sand and Gravel Pit
Rivercrest
Storrs Pond
Oak Hill
CAMPGROUND
SKI LIFT
Camp Brook
Ski Jump
RESERVOIR
Balch Hill
KRASSE
Occom Pond
Golf Course
HANOVER
APPALACHIAN TRAIL
Shelter
Velvet Rocks
Hanover Res
NATIONAL PROGRAM OF INSPECTION OF
NON FEDERAL DAMS
STORRS POND DAM
POSSIBLE FLOOD DAMAGE AREA
Hanover, New Hampshire
USGS Quad Hanover, Vt.–N.H.
Scale 1:24,000
0 FEET 1000

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS


Storrs Pond
OVERVIEW PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
STORRS POND DAM

END

FILMED

8-85

DTIC